Profound Simplicity[1]

Today, since we are dedicating a Systems Engineering Institute, I will speak of Systems Engineering and what makes it possible. Engineering is fundamentally problem solving. Systems engineering is the solving of large and complex problems. I know little of what scholars say on the subject of Systems Engineering, but I know what experience taught me, and I speak from a view reflecting some 50 years of experience, the capstone of which was the Aegis program. In the world of Systems Engineering, which is experiential rather than abstract, experience is well ahead of the theory. One of the challenges for this Institute will be to reflect on experience and codify the generalizations from that experience which will become Systems Engineering theory.

Aegis was the seminal Systems Engineering of a ship as a complete combat system in the United States Navy so it is a good place to start reflecting on experience. Many have extolled our foresight, brilliance and diligence in Aegis. Others have ascribed to us a surfeit of money, talent and time with which any leader and his team could have been successful. As much as I

[1] Remarks by RADM(ret) Wayne E. Meyer at the commemoration of the Naval Post Graduate School Wayne E. Meyer Systems Engineering Institute

enjoy the point-of-view of the former and disdain the latter, they were both wrong.

We, on the Aegis team, were a relentlessly persistent band of brothers who plodded determinedly through a myriad of details every day. We did not seek the “final answer” or the “ultimate solution”, we sought to understand and solve each individual problem and thus eventually achieve a set of correctly solved problems that were properly related to form a meaningful whole. While we had a vision of that whole, that vision changed as we encountered and solved individual problems, or found ways to work around them.

As I reflect on the magnificent effort that the hundreds of dedicated people, comprising the Aegis team, made over a number of years, I am filled with both pride and awe. Pride comes in our accomplishments; the awe comes in reflecting on what a complex undertaking it was. If we had thought of it in the whole as we approached the project, the Great Aegis fleet would probably not sail today.

I have had the wonderful good fortune to attend every Aegis ship commissioning to-date. Thus, I have had some years now to observe the success of Aegis and reflect on the System Engineering effort that it was. I have tried to capture in a few words what distinguished us from many other large Systems Engineering undertakings, which were less successful. I believe that the term "Profound Simplicity" captures the essence of what made us different. Profound Simplicities are the things that take the essence of a complex system or organization and make it understandable in individual human terms.

The first "Profound Simplicity" is that individual humans get work done. Organizations do not do work, they are the manifestation of the rules and relationships among individuals who do the work. We found a way in Aegis to give each individual a sense of belonging and being an appreciated member of the team. A simple thing, like having a phone listing of the Aegis team members, let them know they were on the team. And when, as one did, they receive a breakfast phone call at a Mexican restaurant in the middle of the Mohave Desert from the Aegis director, they know they are on the team. A simple thing like having the Division Manager of a corporation undergoing an award-fee review, sit in but not vote, in the fee deliberation

assured them that they were a trusted member of the team. It also did wonders for communication; there were no questions in the Division manager's mind as to what was on the government teams mind. The OPNAV sponsor, Project Manager and their staffs together designing the CIC of TICONDEROGA at the Applied Physics Laboratory, demonstrated the close working relationship between the warrior and weaponeer. So the first understanding of Systems Engineering is that if you are going to have a coherent complex product, you must have a coherent and compatible team.

We used a lot of shorthand colloquial expressions in Aegis that were the heart of our Profound Simplicities. For example, WTP, or What is The Problem, started most of our discussions and was embedded in our thinking. As you solve problems, which what engineering is about, you must first be sure you know what the problem is that you are trying to solve. An understanding of the problem gives you a sense of the potential solutions. It is amazing to often see how far discussions and work can proceed before there is a clear understanding of the problem. We were clear on what was our problem, "defeat cruise missiles and multiple-aircraft raids."

Once you understand the problem and it has been communicated to all members of the team, you must insure that they continue to work on the same problem. To insure that this occurred, invoked another Profound Simplicity; there will be one threat handbook and from it comes the approved threat that we are all designing a system to defeat. Any time we evaluated our work, it had to be against that threat.

From this defined threat, came other Profound Simplicities that defined the technical requirements of the parts to the whole. They were called Operational Cornerstones. They defined the fundamentals of performance of the system. They included such things as detection range, reaction time and other basic performance characteristics of the system. They were inviolate. Every engineer on the team knew what the cornerstones were and why they had been defined as they were. All parts must support achievement of the cornerstones; there was no freelancing when it came to systems performance.

When approaching a complex problem it is tempting to look for the ultimate solution and final answer. This often results in construction of a complex system with inextricable embedded pieces with little hope of isolating and

solving the problems that inevitably occur. Our approach was captured in the phrase “Build a little, test a little, learn a lot”. That is a simple way of saying that you approach a complex problem incrementally and understand and proof the individual pieces before you incorporate them in the final system. Embedded in that BALTALLAL, is also the concept of “look at all the data all the time.” This embodies a Rickover Simplicity that “the devil is in the details.” Sound engineering demands relentless attention to details.

Having defined the problem, bounded the performance parameters and frozen the threat was not sufficient. A common language or lexicon had to be developed so that when disparate team members working on major, but separate pieces of the ultimate whole, could unambiguously communicate with each other. Ambiguous terms, such as “software” were banished to the “forbidden word” list. When we talked about a computer program or a written report, both of which are “software”, we knew the difference.

We have dealt, thus far, with the complexity of the Aegis system and the Aegis team. In large Systems Engineering efforts, beyond complexity, there is also an element of uncertainty. We dealt with this in several ways. One of the best-known Profound Simplicities was “spend it like you got it”. This

reflected the understanding that time is your enemy and that inaction because of any uncertainty of future funding could be deadly. It also posited a commitment to success that is critical to team confidence. Another way we dealt with uncertainty was the demonstrated complete loyalty of the Aegis director to the team. Problems of one became challenges for all and funds were adjusted up or down in accordance with the overall need and best interest of the complete Aegis system. This avoided sub-optimization at cost to the system and it assured each organization they would have help in solving their problems and they were expected to contribute to the solution of other organizations problems. This team effort at solving both technical and fiscal problems encouraged team members to expose problems rather than hide them until they became embedded cancers in the system, hard to detect and more difficult to remove.

In the briefest of terms I have reflected on what I believe were some of the key findings that come out of the Aegis experience as the seminal Systems Engineered Combat System in the Navy. Now let me turn to some thoughts on the Institute we dedicate today. Joint, combined and allied forces beget major systems demands that make this Institute at this Institution right for the times.

The Institute must do many things, but two are critical. First it must learn from the past and develop generalizations from that past that will serve as support to systems engineers of the future. As I mentioned earlier, in engineering, unlike science, experience precedes theory. Science is a deductive process and systems engineering theory is an inductive process. Data points from successful engineering projects must be gathered together to distill the common points or generalizations that characterize them. While Aegis is a good place to start, other projects, such as the Nuclear Power Program, FBM within the Navy should be examined. Failures, as well as successes should be examined, other DoD programs and civilian efforts should also be included. Case studies are a good way to look at programs and the students can be involved in creating the case studies as well as evaluating them to distill general principles relevant to Systems Engineering.

Second, the Institute must work on today's WTP. The WTP of today is ballistic missile defense. As the person for whom your Institute is named I hereby stipulate that your first Systems Engineering challenge is ballistic missile defense from the sea.

Now let me address an issue that is personal and emotional, but very important to me-that is the Aegis team members who were major players in our success, some of whom are no longer with us. Many of the key players are here today. I cannot mention them all, so I will only mention one. Aegis would never have gone to sea without the "high cover" of VADM Jim Doyle in OP-03. We will always remember and appreciate the many battles he fought for us and we are honored to have him present today.

Now let me mention a few of those who are no longer with us. They include Admiral Roger Elmore Spreen, "Little George" Luke, Bill Goodwin, Harvey Scheer and Don May. These and many others I could mention were men, from whom I drew support, advice and comfort as we fought the many battles of Aegis. They inspired me at all times, criticized me when needed and above all were fiercely loyal to me and to the program.

Any successful endeavor such as Aegis owes its success to many people. Not all of us have the good fortune that I have had to see your child grow up and graduate from concept to combatant. I am sorry that these men did not live to see the full flower of the might Aegis fleet of which they dreamed and to which they devoted much of their life. We owe them much and we miss them mightily.

One of the greatest Profound Simplicities is that “brevity is the sole of virtue”. Permit me to close my brief remarks on a personal note. I am honored to be an alumnus of the Naval Postgraduate School. I am proud and humbled to have my name forever associated with the school through the Wayne E. Meyer Systems Engineering Institute. To the Superintendent, Phil and others who made this come to pass- I thank you. As an alumnus I have supported and tried to represent the Naval Postgraduate School well. I hope that the Institute that we dedicate in my name today will serve the Naval Postgraduate School, its students, and our Navy well in the future.

Let us take pride in the fact that we live in the greatest country in the world and are privileged to have spent our professional life in its service in the greatest Navy in the world. Thank You!